

SECTION 501 PIPE CULVERT AND STORM DRAINS:

501-1 Description:

The work under this section shall consist of furnishing pipe and all other materials required and the installing of pipe, including excavating, and furnishing, placing and compacting backfill material, all in accordance with the details shown on the plans and the requirements of these specifications.

At each location where a pipe is to be installed, the project plans will specify the size and approximate length along with the requirements for each approved option at that location, such as the wall thickness, corrugation configuration, coatings, linings, class and strength.

At each such specified location, pipe of one kind and material shall be selected by the contractor from the options shown. All contiguous pipe and all metal pipe in close proximity shall be of the same kind and material. Special sections, fittings, elbows, branch connections, tapered inlets, end sections, connectors, coupling, and other such items shall be of the same material and coating as the pipe to which they are attached unless otherwise stated in these specifications.

When trenching to depths in excess of five feet is required, prior to construction the contractor shall submit in writing to the Engineer a detailed description of its proposed trenching operations, including shoring methods.

501-2 Materials:

501-2.01 All Pipe Except Nonreinforced, Cast-In-Place:

Except for nonreinforced, cast-in-place concrete pipe, materials shall conform to the requirements of Section 1010.

501-2.02 Nonreinforced, Cast-In-Place:

Concrete for constructing the cast-in-place concrete pipe shall conform to the requirements of Section 1006 for Class S concrete, except as specified herein.

Class S concrete shall have a minimum compressive strength of 3,000 pounds per square inch at 28 days.

The proposed slump in the mix design furnished by the contractor shall be the minimum required to permit proper placement of the concrete without harmful segregation, bleeding or incomplete consolidation.

The maximum size of the coarse aggregate for pipes 48 inches or less in diameter shall be one inch and for pipes larger than 48 inches in diameter shall be 1-1/2 inches.

501-3 Construction Requirements:

501-3.01 Preparation of Foundations, Trenches, and Embankments:

A trench condition is defined as a trench which has vertical slopes to a point at least one foot above the top of the pipe and its maximum width is as detailed on the plans.

Unless specified otherwise, the contractor may install pipe in either a non-trench condition or a trench condition in natural ground or in embankment.

Where rock, hardpan, or other unyielding material is encountered, such material shall be removed below the vertical limits as shown on the plans. The depth to be removed shall be at least 12 inches or as designated by the Engineer. The width to be removed shall depend on whether a trench or non-trench condition exists. If a trench condition exists, the width of the trench as shown on the plans shall be maintained throughout the additional depth. If a non-trench condition exists, the width of the removal shall be a minimum of the outside diameter of the pipe plus two feet for pipe under four feet in diameter, or a minimum of the outside diameter of the pipe plus three feet for pipe of four or more feet in diameter. The overexcavated area shall be backfilled with structure backfill material as designated in Subsection 203-5.03(B)(1) and compacted in layers not exceeding six inches in depth.

When a firm foundation is not encountered at the bottom of the vertical limits as shown on the plans due to soft, spongy, or other unstable soil, such unstable soil shall be removed for a width of at least the horizontal outside dimension of the pipe on each side of the pipe and to the depth specified by the Engineer. The unstable soil removed shall be replaced with structure backfill material as designated in Subsection 203-5.03(B)(1) and compacted in six-inch lifts.

The completed foundation shall be firm for its full length and width. When specified on the project plans, the foundation shall have a longitudinal camber of the magnitude specified.

501-3.02 Bedding:

(A) Bedding Material:

(1) General:

Bedding material for all pipe shall conform to the following aggregate gradation:

Sieve Size	Percent Passing
1-1/2 inch	100
1 inch	90 - 100
No. 8	35 - 80
No. 200	0 - 8.0

The plasticity index of the bedding material for all pipe shall not exceed 8 when tested in accordance with the requirements of AASHTO T 90.

Bedding material for all pipe shall have a value of resistivity not less than 2,000 ohm-centimeters unless otherwise specified or approved by the Engineer. Bedding material

shall have a pH value between 6.0 and 10.0, inclusive, for all metal pipe installations except aluminum. Bedding material for aluminum pipe installations shall have a pH value between 6.0 and 9.0, inclusive. Bedding material shall have a pH value between 6.0 and 12.0, inclusive, for all concrete or plastic pipe installations. Tests for pH and resistivity shall be in accordance with the requirements of Arizona Test Method 236.

(2) Standard Aggregate Bedding Material:

Standard bedding material shall conform to the aggregate requirements here-in-before specified and may be compacted, jetted or placed as an aggregate slurry as herein specified.

The maximum water content in an aggregate slurry mixture shall be 35 gallons of water per ton of bedding material. Unless otherwise approved by the Engineer, the slurry shall be compacted with internal vibrators in accordance with the requirements of Subsection 601-3.03(D). Aggregate slurry shall be thoroughly mixed in a mixer approved by the Engineer.

(3) Cement-Treated Slurry Bedding Material:

When pipe culverts or storm drains 36 inches in diameter or larger are placed in a trench, the bedding material from bottom of pipe to springline shall be a cement-treated slurry. Cement-treated slurry bedding material shall conform to the gradation specified for bedding material under Subsection 501-3.02(A)(1) and additionally shall have a cement content of one sack per cubic yard. Cement-treated slurry shall be thoroughly mixed in a mixer or at a central batch plant as approved by the Engineer and shall have a slump of eight to 11 inches.

(B) Placement of Bedding Material:

(1) General:

All trash, forms, sheeting, bracing, and loose rock or loose earth shall be removed from the area into which bedding material is to be placed.

Bedding material shall be placed under and around the pipe to the elevation at the point of maximum width of the pipe (springline), as shown on the plans. At the contractor's option, bedding material may be placed above the springline of the pipe.

Bedding material shall be placed in a manner which will prevent distortion, damage to, or displacement of the pipe from its intended location. Bedding material shall also be placed so that adequate support will be provided in the haunch support areas for the pipe. Voids or loose soils which are found to occur due to improper placement or compaction of bedding materials will result in rejection of that portion of the pipe installation. Replacement of the pipe will be at no additional cost to the Department.

(2) Standard Aggregate Bedding Material:

Standard aggregate bedding material shall be placed either in uniform horizontal layers not exceeding eight inches in depth before compaction or in uniform horizontal layers not exceeding four feet in depth when placed as a slurry. Bedding material may also be placed in uniform horizontal layers not exceeding four feet in depth when compaction is done by jetting.

(3) Cement-Treated Slurry Bedding Material:

Cement-treated slurry bedding material shall be placed in a uniform manner that will prevent voids in, or segregation of, the bedding material, and will not float or shift the culvert or pipe. Cement-treated slurry bedding material shall be placed from bottom of pipe to pipe springline. No backfilling above the cement-treated slurry shall be commenced until 24 hours after the cement-treated slurry has been placed.

(C) Compaction of Bedding Material:

(1) General:

Compaction of bedding material shall be performed without damage to the pipe and surrounding in-place material. Special care shall be taken in placing, shaping and compacting all bedding material under haunches of pipe to prevent moving the pipe or raising it from its bedding.

(2) Standard Aggregate Bedding Materials:

Standard aggregate bedding material shall be compacted to at least 95 percent of the maximum density determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

When standard aggregate bedding material is placed as an aggregate slurry or compacted by jetting, the material placed below the springline of the pipe shall be compacted prior to placement of material above the springline of the pipe.

Jetting shall not be used for any material placed more than one foot above the top of the pipe.

Ponding will not be permitted in any case.

Jetting shall be done in such a manner that water will not be impounded. Jetting methods shall be supplemented by the use of vibratory or other compaction equipment when necessary to obtain the required compaction. Bedding material compacted by jetting shall use the least amount of water that will properly consolidate the material and move the material under the pipe to eliminate voids. A jetting probe shall be inserted into the material. It shall be of such length as to reach the material under the pipe. Water shall be provided to the jetting probe at a minimum pressure of 30 pounds per square inch. The jetting probe shall be inserted at uniformly spaced intervals on both sides of the pipe, a maximum spacing of three feet.

The contractor shall excavate holes in the compacted aggregate slurry or jetted bedding material to the depths and at the locations designated by the Engineer. These holes shall be of such size as to allow the required density testing to be performed in a safe manner. Upon completion of the tests, the contractor shall refill the excavated areas and compact the material to the required density in a manner satisfactory to the Engineer.

(3) Cement-Treated Slurry Bedding Material:

Cement-treated slurry bedding material shall not require additional compaction after placement up to pipe springline if it meets the material requirements of Subsection 501-3.02(A) and is placed as outlined in Subsection 501-3.02(B). The Engineer may require the use of vibrators with cement-treated slurry bedding if the fluidity of the mixture is not sufficient to fill all voids. No density tests will be required in the cement-treated slurry bedding material as placed up to pipe springline.

501-3.03 Installation:

(A) General:

Pipe shall be handled carefully. Proper facilities shall be provided for handling and lowering the sections of pipe. All pipes which show defects due to negligence or rough handling shall be removed and replaced if so ordered by the Engineer. If damaged galvanized steel pipe is not replaced it shall be repaired in accordance with the requirements of AASHTO M 36. Damage to the coating of bituminous coated pipe shall be repaired using material conforming to the requirements of AASHTO M 190.

Pipe shall be installed in reasonably close conformity with the lines, grades and dimensions shown on the project plans or specified by the Engineer.

Prior to the staking of pipe culverts a study of the normal flow of the drainage shall be made. As a result of the study, a change in length or location of pipe may be required as approved by the Engineer to attain proper placement of the pipe. Pipe profiles shall be approved by the Engineer prior to constructing or installing each structure.

Unless otherwise permitted by the Engineer, the installing of the pipe shall begin at the downstream end.

Bell or groove ends of rigid conduits and outside circumferential laps of flexible conduits shall be placed facing upstream.

Helical corrugated pipe shall be installed with the separate sections firmly joined together with the corrugations in alignment.

Where there is restricted cover, the bolts of the bands connecting flexible pipe shall be advanced so that the tops of the bolts will be in line with or below the top of the pipe.

When aluminum alloys come in contact with concrete, the contacting surfaces shall be coated either with asphalt mastic conforming to the requirements of AASHTO M 243 or with aluminum-impregnated caulking compound.

When specified on the project plans, the vertical diameter of round, flexible conduit shall be increased five percent by shop elongation.

Any pipe which is not in true alignment or which shows undue settlement after laying or is damaged shall be removed. The trench shall be prepared as hereinbefore specified and the pipe shall be installed again. Any pipe which, in the opinion of the Engineer, is damaged so that it cannot be used shall be replaced.

Paved or partially lined flexible pipe shall be installed so that the longitudinal center line of the paved segment coincides with the flow line. Elliptical and elliptically reinforced rigid pipe shall be installed with the major axis within five degrees of a vertical plane through the longitudinal axis of the pipe.

The interior of all pipes shall be free of dirt and foreign material as the work progresses and all pipes shall be left clean at the time of final acceptance.

Connections to new or existing pipes or structures shall be made in accordance with the details shown on the project plans or as may be ordered by the Engineer in order to complete the work specified.

When using metal safety end sections, the embankment slope shall be warped to match the end section.

For a skewed pipe installation, the toe of the embankment slope shall be warped to match the toe of the skewed metal safety end section in order to provide effective drainage.

When metal safety end sections are used, the bolts in the safety bars shall be torqued at 70 foot-pounds.

(B) Full Circle Corrugated Metal Pipe:

(1) General:

Field joints for each type of corrugated metal pipe shall provide circumferential and longitudinal strength to maintain the pipe alignment, prevent separation of the pipe, prevent infiltration of side fill material, and prevent leakage of water into the surrounding soil. Coupling bands and gaskets shall conform to the requirements of Subsection 1010-2.01.

Corrugations in the coupling bands shall have the same dimensions as the corrugations in the pipes being connected. Pipe fabricated with helical corrugations shall have the ends re-rolled to circumferential corrugations to facilitate coupling. The re-rolled end shall extend a minimum of two corrugations from the end of the pipe.

When a new pipe is to be connected to the end of an existing in-place helical pipe, a coupling band with projections (dimples) may be used to make the connection.

Bands for pipe diameters to 72 inches, inclusive, and corrugation sizes of 2-2/3 by 1/2 or three by one inches shall be at least 10-1/2 inches wide. Bands for pipes 36 to 72 inches in diameter, inclusive, with corrugations five by one inches shall be at least 12 inches wide. Bands shall have two circumferential rows of projections. The rows of projections shall be spaced to provide equal contact on each side of the pipes being joined.

When bands with projections (dimples) are used to join new pipe to existing pipe, the joints shall be sealed with a continuous sponge rubber strip. The strip shall conform to the minimum requirements of ASTM D 1056, Grade 2A1, and shall be at least 7 inches wide and 3/8 inch thick.

Where existing pipes are to be extended, the ends of the existing pipe shall be in such condition that the new pipe can be firmly joined to form an acceptable joint. All existing pipe ends that are damaged or are out of shape such that they cannot be joined in an acceptable manner shall be repaired.

Damaged galvanized coating shall be cleaned with a wire brush and the damaged area painted with at least one full coat of zinc paint, as specified in Subsection 1002-2.02. If the Engineer determines that the end of an existing pipe is damaged to the extent that it cannot be repaired sufficiently to be joined properly to the new pipe, the damaged portion shall be removed.

Where prefabricated pipe fittings are to be installed in existing pipes, a portion of the existing pipe shall be removed in order to accommodate the fitting.

(2) Watertight and Water Resistant Joints:

Watertight joints shall be provided for siphon and irrigation pipe installation and when specified in the Special Provisions, standard drawings, or shown on the project plans. Watertight joints, unless otherwise specified, will not be required for storm drains, culverts, or other drainage pipe, however, joints for these pipes shall be water resistant.

Watertight and water resistant joints shall conform to the requirements of Subsection 1010-2.01 of the specifications. When watertight joints are shown on the project plans or specified in the Special Provisions, the assembled joint shall pass a performance test, as specified herein or as approved by the Engineer, without significant leakage at the joint:

- (a) A hydrostatic pressure test on a joint shall be made on an assembly of two sections of pipe, properly connected in accordance with the joint design. At the option of the contractor, suitable bulkheads shall be provided within the pipe adjacent to and on either side of the joint, or the outer ends of the two joined pipe sections shall be bulkheaded. No mortar or concrete coatings, fillings, or packings in addition to that normally required for the joint shall be placed prior to watertightness tests. After the pipe sections are fitted together with the gasket or gaskets in place, the assembly shall be subjected to a pressure resulting

from a head of 10 feet of water above the crown of the pipe for 10 minutes. Moisture of beads of water appearing on the surface of the joint will not be considered as leakage. The tests on individual joints may be performed at the fabricator's facility or at the job site.

The joint watertightness test shall be performed on pipe sections in straight alignment and on pipe sections deflected from straight alignment. When testing pipe sections not on straight alignment, the pipe sections shall be positioned to create a gap on one side of the outside perimeter of the pipe that is 1/2 inch wider than the gap for pipe sections in straight alignment. When coupling bands are used to test pipe sections not on straight alignment and the maximum gap on one side of the outside perimeter of the pipe is less than 1/2 inch wider than that for pipe sections in straight alignment, said coupling band pipe sections shall be positioned to provide maximum gap.

- (b) Joints, other than watertight joints, which employ rubber gaskets, whether flat or "O" rings, will be considered water resistant. No testing will be required to establish that condition.

The contractor shall furnish to the Engineer a Certificate of Compliance, in accordance with the provisions in Subsection 106.05 of the specifications, that the material being furnished conforms to the joint property requirements as described herein. Field tests may be required by the Engineer whenever there is a question regarding compliance with these requirements.

(C) Slotted Pipe:

Slotted pipe shall be joined with coupling bands as shown on the project plans and the joint shall be made water resistant. Prior to attaching the coupling band, sealant material shall be placed between the coupling band and the periphery of the pipe section ends.

Prior to backfilling and paving operations, the slot shall be covered to prevent infiltration of material into the pipe. Heavy tape, roofing paper, timber or other material may be used. Coverings shall be removed when the paving operations have been completed.

Slotted pipe shall be backfilled with grout in accordance with the details shown on the project plans. The grout shall conform to the requirements of Subsection 913-2.04. Grout shall not be placed when a descending air temperature falls below 40 degrees F or until an ascending air temperature exceeds 35 degrees F. Temperatures shall be taken in the shade and away from artificial heat. The grout shall be cured in accordance with the requirements of Subsection 912-3.09.

(D) Precast Concrete Pipe:

Pipe sections shall be jointed such that the inner surfaces are reasonably flush and even, and the ends are centered as required.

Unless a particular type of joint is specified on the project plans, joints shall be made with Portland cement mortar, Portland cement grout, rubber gaskets, plastic sealing compound, or any other type approved by the Engineer.

Self-centering tongue and groove mortar joints shall be finished smooth on the inside. For diapered joints, diapers shall be used to retain the poured grout. Joints shall be thoroughly wetted before mortar or grout is applied.

When Portland cement mixtures are used, the completed joints shall be protected against rapid drying by means of an approved curing method. No joint shall be grouted until the following two sections of pipe are laid.

When required, flexible watertight gasketed joints shall be installed on the pipe in accordance with the requirements of AASHTO M 198, Paragraph 5.1.

(E) Spiral Rib Corrugated Metal Pipe:

Spiral rib corrugated metal pipe shall be installed in accordance with the requirements specified in Subsection 501-3.03(B) for full circle corrugated metal pipe, except as otherwise specified herein. Special care shall be taken during placement of the pipe and backfilling to avoid damage to the pipe.

Lateral field connections between metal pipes shall be welded and any galvanizing damaged by welding shall be repaired in accordance with the requirements of Subsection 1010-2(A). Coupling bands shall be supplied in accordance with Subsection 1010-2.03(C).

The coupling bands used to connect spiral rib pipe sections shall be hugger-type bands, made from the same material as the pipe, or other approved design, and shall be fitted with gaskets or "O" rings fabricated from neoprene or butyl rubber or other durable, resilient material approved by the Engineer, and assembled in such a manner as to form a sealed joint. "O" ring gaskets required for watertight joints shall be composed of rubber as specified in ASTM C 361, Section 6.9, and shall be placed in the first corrugation of each pipe end and shall be compressed by tightening the coupling band, in accordance with the manufacturer's installation instructions.

(F) Concrete-Lined Corrugated Metal Pipe:

Concrete-lined corrugated metal pipe shall be installed in accordance with the requirements specified in Subsection 501-3.03(B) for full circle corrugated metal pipe, except as otherwise specified herein.

Pipe shall be joined with hugger-type bands which are 0.064 inches in thickness, of the same material as the pipe, and shall be two-piece for pipe greater than 48 inches in diameter.

Coupling bands, in addition to the requirements specified in Subsection 1010-2.02(A), shall be a minimum of 10-1/2 inches wide, formed with two corrugations that are spaced to provide nesting in the second corrugation of each pipe end and shall be drawn together by

a minimum of two galvanized bolts, 1/2 inch in diameter, inserted in a bar held in place by a strap welded to the pipe. Bands drawn together by other connection arrangements, such as angles, shall not be allowed. "O" ring gaskets required for watertight joints shall be composed of rubber as specified in ASTM C 361, Section 6.9, and shall be placed in the first corrugation of each pipe end and shall be compressed by tightening the coupling bands in accordance with the manufacturer's installation instructions.

(G) Corrugated High Density Polyethylene Plastic Pipe:

Corrugated high density polyethylene plastic pipe shall be assembled and installed in accordance with the manufacturer's instructions.

Watertight joints, unless otherwise specified, will not be required for storm drains, culverts, or other drainage pipes. However, joints for these pipes shall be water resistant. Watertight joints shall be provided for siphon and irrigation pipe installations.

Watertight and water resistant joints shall conform to the requirements of Subsection 1010-8 of these specifications.

A six- by eighteen-inch strip of magnetic tape shall be placed in the trench at the crown of each length of installed pipe.

Special care shall be taken in the handling and installation of corrugated high density polyethylene plastic pipe and fittings to prevent damage and to assure that proper line and pipe grade are maintained throughout the backfilling operation.

When end sections for corrugated high density polyethylene plastic pipe are called for on the plans, the contractor shall use metal safety end sections unless otherwise specified.

501-3.04 Backfilling and Compacting:

(A) Backfill Material:

(1) Pipe Backfill:

Pipe backfill material shall be selected from excavation or from a source selected by the contractor. It shall not contain frozen lumps, stones larger than three inches in diameter, chunks of clay or other objectionable material. Backfill material to be used for pipes, pipe-arches or arches made of metal shall have a value of resistivity not less than 2,000 ohm-centimeters or the value shown on the project plans. When resistivity is not shown on the plans, the backfill material shall have a value of resistivity not less than that of the existing in-place material or 2,000 ohm-centimeters, whichever is less. Backfill material shall have a pH value between 6.0 and 10.0, inclusive, for all metal pipe installations, except aluminum. Backfill material for aluminum pipe installations shall have a pH value between 6.0 and 9.0, inclusive. Backfill material shall have a pH value between 6.0 and 12.0, inclusive, for all concrete or plastic pipe installations. Tests for pH and resistivity shall be in accordance with the requirements of Arizona Test Method 236.

Pipe backfill material shall conform to the following gradation:

Sieve Size	Percent Passing
3 inch	100
3/4 inch	60 - 100
No. 8	35 - 80
No. 200	0 - 12.0

The plasticity index shall not exceed 12 when tested in accordance with the requirements of AASHTO T 90.

As an alternate, pipe backfill may conform to the material requirements listed for bedding material as specified in Subsection 501-3.02(A), for standard aggregate bedding material or cement-treated slurry bedding material.

(2) Trench Backfill:

Trench backfill material shall not contain organic material, rubbish, debris and other deleterious material and shall not contain solid material which exceeds eight inches in greatest dimension and shall be soil selected from excavation or from a source selected by the contractor.

As an alternate, trench backfill may conform to the material requirements listed for bedding material as specified in Subsection 501-3.02(A) for standard aggregate bedding material or cement-treated slurry bedding material.

(3) Slope Plating:

The roadway slope at the inlet ends of pipe culverts shall be plated with an impervious material. The plating material shall be a fine-grained, cohesive material with at least 50 percent of it passing the No. 40 sieve and with a plasticity index of at least 10 and shall be placed as shown on the plans. The plasticity index will be determined in accordance with the requirements of AASHTO T 90.

(B) Placement of Backfill Material:

(1) General:

All trash, forms, sheeting, bracing, and loose rock or loose earth shall be removed from the areas to be backfilled before backfill material is placed.

Backfill compacted by pneumatic or mechanical tamping devices, shall be placed in layers not more than eight inches in depth before compaction.

Pipe backfill shall be brought up evenly on both sides of the pipe for the full length to an elevation one foot above the top of the pipe.

Trench backfill shall be placed from one foot above the top of the pipe to the elevation at which base or surfacing materials are to be placed or to the top of the trench.

Backfill material shall be placed around and over arches in accordance with the requirements of Section 502.

(2) Standard Aggregate Slurry:

Pipe backfill or trench backfill mixed as a standard aggregate slurry shall be placed in uniform horizontal layers not exceeding four feet in depth. The slurry shall be compacted with internal vibrators in accordance with the requirements of Subsection 601-3.03(D).

(3) Cement-Treated Slurry:

Cement-treated slurry pipe backfill placement above springline shall not commence within 24 hours of the placement of the underlying cement-treated bedding material below springline. Cement-treated pipe backfill shall be placed in a uniform manner that will prevent voids in or segregation of the backfill to an elevation one foot above the top of the pipe. No backfilling above the cement-treated slurry pipe backfill shall be commenced until 24 hours after the cement-treated slurry has been placed.

If cement-treated slurry bedding material is used for trench backfill, it shall not be disturbed or loaded in any manner within 24 hours of placement as above.

(C) Compaction of Backfill Material:

Backfill material shall be compacted to at least 95 percent of the maximum density determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual, as directed and approved by the Engineer.

Jetting shall not be used to compact pipe backfill, trench backfill or any material placed more than one foot above the top of the pipe.

Ponding will not be allowed in any case.

If trench backfill or pipe backfill is placed as an aggregate slurry, the contractor shall excavate holes in the compacted slurry to the depths and at the locations designated by the Engineer. These holes shall be of such size as to allow the required density tests to be performed in a safe manner. Upon completion of the tests, the contractor shall refill the excavated areas and compact the material to the required density in a manner satisfactory to the Engineer.

Cement-treated slurry bedding material for pipe backfill shall not require additional compaction after placement up to an elevation one foot above the top of pipe if it meets the material requirements of Subsection 501-3.02(A) and is placed and compacted as outlined in Subsection 501-3.04(B) and (C). No density tests will be required in the cement-treated slurry bedding material when it is utilized for pipe backfill to an elevation one foot above the top of pipe.

Cement-treated slurry bedding material used for trench backfill shall meet the requirements listed above for pipe backfill up to the elevation which it is placed.

501-3.05 Filter Material:

When shown on the project plans or specified in the Special Provisions, filter material shall be carefully placed around perforated pipe.

Filter material shall conform to the grading requirements for fine aggregate in Section 1006 and shall be placed in accordance with the details shown on the project plans.

501-3.06 Encasement of Pipe:

When shown on the project plans, pipe shall be encased in Class B concrete. Portland cement concrete shall conform to the requirements of Section 1006.

501-3.07 Nonreinforced, Cast-In-Place Concrete Pipe:

(A) General Requirements:

The contractor shall have previously installed cast-in-place pipe similar to the pipe specified in this contract. The Engineer may require the contractor to submit a list of names of the contractor's key personnel with their cast-in-place pipe experience. When required, the list shall include the foreman and equipment operators.

When the project plans include cast-in-place concrete pipe as an alternate, the contractor shall review all geotechnical investigations available for the project. The geotechnical investigations are available at ADOT Materials Group, 1221 N. 21st Avenue, Phoenix, Arizona 85009, phone (602) 712-7231. The contractor shall be responsible to determine if the in-place soil conditions will allow the specified trench to be constructed.

The contractor shall provide a quality control administrator who shall be responsible for cast-in-place pipe quality. The administrator shall be a full time employee of the contractor or a consultant engaged by the contractor. The contractor shall provide documentation to the Engineer which demonstrates the quality control administrator's experience in the manufacture and placement of cast-in-place pipe. The administrator shall have the authority to control all activities necessary to ensure a product of acceptable quality, including strength, alignment, thickness, and grade.

The contractor's quality control administrator shall inspect the pipe construction and complete a daily observation form, supplied by the Engineer. The form shall be completed and submitted to the Engineer no later than 9:00 a.m. on the first working day following each day work is being performed on the pipe installation.

Nonreinforced, cast-in-place concrete pipe shall be cast monolithically in a prepared trench at the locations and in accordance with the details shown on the project plans and the requirements of these specifications.

The pipe shall be constructed with equipment specifically designed for constructing cast-in-place, monolithic concrete pipe. The equipment shall be approved by the Engineer prior to use, and the contractor may be required to furnish evidence of successful operation of the equipment on similar work. If, in the opinion of the Engineer, the equipment furnished is not suitable to produce the quality of work specified, its use will not be permitted for the work.

Pipe shall be constructed in trenches which have been excavated in either native soil or compacted fill. The trench walls shall be stable so that the planned shape of the trench is maintained.

The minimum inside diameter of the pipe, measured in any direction, shall be at least 98 percent of the nominal pipe size. The minimum wall thickness will be as specified on the project plans for each pipe size.

(B) Excavation:

The trench shall be excavated to the lines and grades shown on the project plans. Laser guided alignment instruments shall be used to control the grade and alignment of the trench. Departure from and return to the established grade for the finished trench shall not exceed one inch per ten linear feet, with a total departure not to exceed 1.5 inches. Departure from and return to specified alignment for the trench shall not exceed two inches per ten linear feet, with a total departure not to exceed four inches. The bottom of the trench shall be shaped in accordance with the details shown on the project plans and prepared to provide full, firm and uniform support over the bottom 210 degrees of the pipe to be constructed.

The length of trench permitted to remain open at any one time shall not exceed 1,600 linear feet, unless otherwise specified in the Special Provisions or as may be permitted by the Engineer.

The bottom of the trench must consist of either undisturbed native soil or compacted backfill.

When, in the opinion of the Engineer, soft, spongy or other unsuitable material is encountered in the bottom of the trench, such unsuitable material shall be removed to the depth and width directed by the Engineer. The resulting area shall be backfilled with material conforming to the requirements of Subsection 501-3.04(A)(1). The backfill shall be compacted in accordance with the requirements of Subsection 501-3.04(C). The trench shall then be excavated as specified above.

When boulders, bedrock, or rock ledges are encountered in the bottom or side walls of the trench, such material shall be removed to a distance of at least six inches from the nearest surface of the pipe, and the space then backfilled, compacted, and reshaped as required above for unsuitable material.

The trench walls, from a point one foot above the top of the pipe to the top of the trench, may be sloped as required by soil conditions to provide more stability in the trench and

safer working conditions in accordance with the provisions of Subsection 107.07. The steepness of the side slopes shall be limited to the degree of stability considered necessary for safety, unless an approved shoring system is used. Side slopes shall conform to current OSHA regulations and be approved by the Engineer.

(C) Concrete Placement:

At the time of concrete placement, all surfaces in the trench which will be in contact with the pipe shall be thoroughly moistened so that moisture will not be drawn from the freshly placed concrete; however, the trench shall be free of standing water, mud and debris.

The concrete shall be placed around the full circumference of the pipe in one operation. When metal forms are used, they shall be of sufficient strength to withstand vibrating and tamping of the concrete.

The concrete shall be vibrated, rammed, tamped or worked with suitable devices until the concrete has been thoroughly consolidated and completely fills the formed space.

Laser guided alignment instruments shall be used to control the grade and alignment of the pipe. Departure from and return to the established grade for the invert of the installed pipe shall not exceed one inch per ten linear feet, with a total departure not to exceed 1.5 inches. The surface of the invert shall not vary by more than 0.10 feet when tested with a ten foot straight edge. Departures from and return to specified alignment for the pipe shall not exceed two inches per ten linear feet, with a total departure not to exceed four inches.

When placing operations stop for such a time that initial set of the concrete is likely to occur before placement resumes, a construction joint shall be made by leaving the end of the pipe rough with a slope of approximately 45 degrees and inserting 24-inch No. 4 dowels one foot into the center of the pipe wall at approximately 18-inch intervals.

Collars may be used in lieu of doweled joints. An excavation shall be made along the sides and bottom of the construction joint to permit casting of a concrete collar around the outside of the joint. The collar shall have a minimum thickness 1.25 times the pipe wall thickness and shall lap the entire joint by at least two times the wall thickness.

Immediately before resuming concrete placement, the joint shall be cleaned of all laitance, loose or defective concrete, coatings and other deleterious materials, and thoroughly wetted.

Construction joints used for connections to another pipe or at junction structures shall be made by squaring off the end of the pipe. An excavation along the sides and bottom of the pipe to permit casting of the concrete collar shall be made as previously specified.

After the removal of forms, the inside of the pipe will be inspected for rock pockets, voids, form indentation, and excessive form lap. Any necessary repairs shall be made within 24 hours and to the satisfaction of the Engineer. Cracks shall be repaired in accordance with Subsection 501-3.07(G).

(D) Finishing:

The interior surface and exterior top surface of the pipe shall be as smooth as a wood-float finish and shall be essentially free of fractures, cracks and roughness.

(E) Curing:

Within 15 minutes after the pipe is cast, the concrete forming the exposed top portion of the pipe shall be cured as follows:

The pipe shall be covered with a polyethylene film conforming to the requirements of AASHTO M 171 except that the nominal thickness shall be 0.0015 inches. The film shall be white opaque or clear and shall be held in place with loose soil to assure continuous contact. The loose soil shall not be greater than six inches in depth at any point, and shall conform to the requirements herein before specified under pipe backfill. This curing method shall be used when the ambient temperature exceeds 100 degrees F.

For ambient air temperatures equal to or less than 100 degrees F, the pipe may be sprayed with a liquid membrane-forming compound conforming to the requirements of Subsection 1006-6(C). If the contractor elects to spray the pipe with a liquid membrane, such procedure shall be completed within 30 minutes.

During the curing period, the inside of the pipeline shall be kept in a humid condition for at least seven days following placement of the concrete. To prevent air drafts from drying the fresh concrete, openings in the pipeline shall be covered during the seven day period, except at locations where work on the pipe is required and only during the time that such work is actually in progress.

(F) Backfilling:

Backfilling shall not start until the concrete has developed a compressive strength of at least 2,500 pounds per square inch.

The type of backfill material, the placement of pipe and trench backfill material, and compaction shall conform to the requirements of Subsection 501-3.04.

(G) Pipe Repair:

The contractor shall perform all interior crack repairs only after backfilling.

Transverse cracks 0.05 inches or more in width shall be cleaned and filled with an elastomeric compound approved by the Engineer. The elastomeric compound shall penetrate into the crack at least 0.38 inches.

A longitudinal crack shall be defined as one which is generally oriented within 30 degrees of the alignment of the pipe.

Longitudinal cracks will be a cause for rejection under any of the following conditions.

- (1) A crack which has caused a surface fault within the pipe with a displacement greater than 0.08 inches.
- (2) A crack width greater than that determined by the formula $0.0005 \times \text{O.D.}$ and that can be penetrated by a standard machinist gauge leaf designated in AASHTO T 280.
- (3) A crack width greater than 0.05 inches and that can be penetrated by a standard machinist gauge leaf designated in AASHTO T 280.

Longitudinally cracked pipes meeting any of the three rejection criteria above may be allowed to remain in place if approved by the Engineer. If the Engineer allows such rejectable pipe to remain, all longitudinal cracks meeting any of the three criteria above shall be repaired by full depth epoxy grouting.

Any section of pipe rejected by the Engineer shall be removed and replaced at no additional cost to the Department.

(H) Pipe Wall Thickness:

The contractor shall measure the thickness at the invert and crown by probing at 25-foot intervals during the placement of concrete. The probe shall be a 3/8-inch round bar at least two inches longer than the wall thickness to be measured. The measurements shall be reported on the daily observation form.

The wall thickness will be measured for acceptance. One hole each shall be drilled at the invert and on each side of the springline, within 200-foot intervals. The drill locations will be determined by the Engineer. The Engineer may require additional holes on curves or in areas which appear to be defective. All holes shall have a minimum diameter of 3/4 inch. If the wall thickness is less than the specified minimum thickness, a core shall be drilled adjacent to the drilled hole.

All cores shall have a minimum diameter of three inches.

The length of the core will be determined in accordance with the requirements of AASHTO T 148.

If the length of the drilled core is deficient, additional cores shall be taken at intervals not to exceed ten feet in each direction from the deficient core until one core which is not deficient is obtained in each direction. The pipe between these two acceptable cores will be rejected. The rejected pipe section shall be removed and replaced with pipe of the specified thickness at no additional cost to the Department.

At all locations where drilled holes or cores have been made, the resulting holes shall be filled with concrete in a manner satisfactory to the Engineer.

501-4 Method of Measurement:

Pipe will be measured by the linear foot parallel to the central axis of the pipeline, and shall include the length of fittings.

Tees, wyes and other branches will be measured as pipe along the central axis of the pipes to the point of intersection of said central axes. Pipe reducers will be measured as pipe of the larger diameter along the central axis.

The end of pipe in closed structures will be considered to be at the intersection of the central axis and the inside face of the wall and for masonry and concrete headwalls it will be considered to be at the intersection of the central axis and the face of the headwall.

End sections will be measured by the number of units installed.

501-5 Basis of Payment:

The accepted quantities of pipe, measured as provided above, will be paid for at the contract unit price complete in place.

Except as hereinafter specified, no separate measurement or payment will be made for excavating trenches and for furnishing, placing and compacting bedding and backfill material as described and specified herein and on the project plans, the cost thereof being considered as included in the contract unit price per foot of pipe.

Payment for the removal of rock, hard pan, other unyielding material, or soft, spongy or other unstable soil below the vertical limits as shown on the plans, and the backfilling of these over-excavated areas, as specified herein and as directed by the Engineer, will be paid for in accordance with the requirements of Subsection 104.02.

When an embankment is constructed prior to the digging of a trench and the installation of a pipe, payment for the construction of the embankment will be made under the appropriate item, such as Roadway Excavation or Borrow. Removal of rock, hard pan, other unyielding material, or soft, spongy or other unstable material from the trench within the embankment will not be considered for payment.

The repairing of the damage to existing pipe ends to which new pipe is to be joined and which cannot be seen in order to be assessed and the removal of any portion of a damaged existing pipe, as specified under Subsection 501-3.03(B) will be paid for in accordance with the provisions of Subsection 104.02.

No measurement or direct payment will be made for furnishing and placing filter material, plating material, fittings, collars, bands and the joining of new and existing pipes.

For cast-in-place pipe, no separate measurement or payment will be made for the excavation or preparation of the trench; for furnishing, placing and compacting backfill material; for pipe repair, when authorized by the Engineer; or for quality control activities; the cost being considered as included in the unit price per foot of pipe.

End sections, measured as provided above, will be paid for at the contract unit price complete in place.

SECTION 502 STRUCTURAL PLATE PIPE, PIPE-ARCHES, AND ARCHES:

502-1 Description:

The work under this section shall consist of furnishing and erecting structural plate pipe, pipe-arches, and arches of the sizes, thicknesses, and dimensions shown on the project plans. They shall be installed at the locations specified on the project plans or as directed by the Engineer in reasonably close conformity to the lines and grades shown on the project plans or as established by the Engineer and the requirements of these specifications.

502-2 Materials:

Materials shall conform to the requirements of Section 1010, unless otherwise specified.

Plates shall be fabricated in accordance with the requirements of either AASHTO M 167, AASHTO M 219 or Federal Specification WW-P-405.

Concrete shall conform to the requirements of Section 1006 for the class and strength shown on the project plans.

Reinforcing steel shall conform to the requirements of Section 1003.

502-3 Construction Requirements:

Excavating bedding and backfilling for the structural plate pipe, pipe-arches, and arches shall be performed as specified under Section 501 and as specified herein and on the project plans. Excavating and backfilling for the concrete footings shall be performed as specified under Subsection 203-5. Placement of reinforcing steel and structural concrete shall conform to the requirements of Sections 605 and 601, respectively.

When backfill material is placed around and over arches before headwalls are in place, the material shall first be placed midway between the ends of the arch, forming as narrow a ramp as possible, until the top of the arch is reached. The ramp shall be constructed evenly from both sides and the material shall be compacted as it is placed. After the two ramps have been constructed to the top of the arch, the remainder of the material shall be placed from the top of the arch both ways from the center to the ends and as evenly as possible on both sides of the arch.

When the headwalls are constructed before any backfill material is placed around and over the arch, the material shall first be placed adjacent to one headwall until the top of the arch is reached after which it shall be dumped from the top of the arch toward the other headwall and as evenly as possible on both sides of the arch.

In multiple installations, extreme care shall be taken so that the backfill material is brought up evenly on each side of each arch so that unequal pressures will be avoided.

Plates shall be formed to provide lap joints with the upstream plate lapping over the downstream plate. The bolt holes shall be so punched that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure will be as indicated on the project plans.

Plates for forming skewed or sloped ends shall be cut to give the angle of skew or slope specified. Burned edges shall be free from oxide and burrs, and shall present a workmanlike finish. Legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

Steel plates shall be punched so that bolt holes along those edges of the plates that will form longitudinal seams in the finished structure will be staggered in rows two inches apart, with one row in the valley and one on the crest of the corrugation. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 inches. The minimum distance from center of hole to edge of plate shall be not less than 1.75 times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than 1/8 inch.

Aluminum plates shall be punched so that bolt holes along those edges of the plates that will form longitudinal seams in the finished structure will be on a double row with a center-to-center dimension of 1-3/4 inches. In all structures the longitudinal seam shall be comprised of two bolts in each valley and crest of each corrugation. The standard center-to-center dimensions of bolt holes that will form the circumferential seam in the finished structure shall be 9-5/8 inches. The minimum distance from the center of hole to the edge of the plate shall not be less than 1.75 times the diameter of the bolt.

Tolerance of all hole diameters and spacing shall be as indicated on the project plans or in the Special Provisions.

Plates shall be erected in their final position by connecting the plates with bolts at longitudinal and circumferential seams. Drift pins may be used to facilitate matching of holes. All plates shall be placed in the order recommended by the manufacturer with joints staggered so that not more than three plates come together at any one point. All bolts shall be drawn tight, without overstress, before beginning the backfill.

Steel bolts for structural-plate sections shall be torqued during installation to a minimum of 100 foot-pounds and a maximum of 300 foot-pounds.

For power-driven tools, the hold-on period may vary from two to five seconds. The bolts for aluminum structural-plate sections shall be torqued during installation to a minimum of 100 foot-pounds and a maximum of 200 foot-pounds. Bolts shall be of sufficient length to provide a full nut.

After structural plate pipe has been erected, all spots where damage has occurred to spelter shall be given two coats of an approved hot asphalt paint, or shall be wire brushed

and given two coats of zinc paint, as specified in Subsection 102-2.02, as directed by the Engineer.

502-4 Method of Measurement:

Structural plate pipe, pipe-arches, and arches will be measured either by the linear foot, or by the lump sum for each structure, installed in place, completed and accepted.

If measurement is made by the linear foot, measurement will be made along the invert center line for pipe and pipe-arches and the average of the springline lengths for arches.

Structural concrete and reinforcing steel used for headwalls and footings will be measured by the cubic yard and by the pound, respectively.

Structural excavation and structure backfill for footings will be measured in accordance with the requirements of Subsection 203-5.04.

502-5 Basis of Payment:

The accepted quantities of work under this section, measured as provided above, will be paid for at the contract lump sum price or the contract unit price per linear foot for the different sizes and thickness of structural plate pipe, pipe-arches and structural plate arches designated in the bidding schedule, complete in place, including excavating and furnishing, placing and compacting backfill material.

Payment for structural concrete used in footings and headwalls will be made as provided in Subsection 601-6. Payment for reinforcing steel used in footings and headwalls will be made as provided in Subsection 605-5. Payment for structural excavation and structure backfill for footings will be made as provided in Subsection 203-5.05.

SECTION 503 CONCRETE CATCH BASINS:

503-1 Description:

The work under this section shall consist of furnishing all materials and constructing or reconstructing concrete catch basins, including excavation, concrete removal and backfill. Work shall be done at the locations designated on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

503-2 Materials:

503-2.01 Concrete:

Portland cement concrete shall conform to the requirements of Section 1006 for Class B concrete.

503-2.02 Reinforcing Steel:

Reinforcing steel bars or mesh shall conform to the requirements of Section 1003.

503-2.03 Masonry Mortar:

Masonry mortar shall be composed by volume of one part Portland cement, two parts fine aggregate, one-fifth part hydrated lime and sufficient water to provide a plastic mixture. The lime shall be considered as an addition to and not as replacing any cement.

Fine aggregate shall conform to the requirements of ASTM C 144. Portland cement and water shall conform to the requirements of Section 1006. Hydrated lime shall conform to the requirements of ASTM C 207, Type N.

Mortar that has been mixed more than one hour shall not be used. Retempering of mortar will not be permitted.

503-2.04 Structural Steel:

Structural steel parts shall conform to the requirements of Section 1004.

503-3 Construction Requirements:

503-3.01 Catch Basins:

Excavation and backfill for the catch basin shall be performed in accordance with the requirements of Subsection 203-5.

Catch basins shall be cast-in-place or, at the option of the contractor, may be precast units. A list of approved precast units will be found in the Special Provisions.

Cast-in-place catch basins shall be constructed in accordance with the requirements of Section 601 and reinforced where called for on the plans in accordance with the requirements of Section 605 in reasonably close conformity to the lines and grades shown on the plans and shall meet adjacent sidewalk, curb or gutter surfaces with no appreciable offsets. The catch basin grates and frames shall be fabricated and installed so that the bearing surfaces of the grates shall rest securely on the bearing surfaces of the grate frames.

Proper equipment shall be provided for lowering the precast sections to position. The tongue end of the section shall be placed in contact with the base structure unless otherwise directed. Not more than two holes shall be cast or drilled in the shell of each section for the purpose of handling and placing. If such holes are provided, they shall be filled and finished with mortar after placing the catch basins. Immediately before joining precast sections, mortar shall be placed continuously around the circumference of the receiving section's contact surface. Any precast section damaged during handling or placing shall be repaired or replaced at the option of the Engineer and at no additional cost to the Department.

When specified on the project plans, aprons shall be constructed in accordance with the details shown on the plans. Aprons shall be constructed from Portland cement concrete or from asphaltic concrete.

When specified on the project plans or ordered by the Engineer, corrugated metal pipe shall be installed as temporary drain for the roadway. The pipes shall be subsequently filled with concrete.

Backfilling of the completed structure shall be in accordance with the requirements of Subsection 203-5.

Performed bituminous joint filler shall be installed where the catch basin concrete will meet new or existing concrete curb pavement.

503-3.02 Reconstruct Catch Basins:

Catch basins shall be reconstructed in reasonably close conformity to the lines and grades shown on the plans. The existing frame and grate shall be carefully removed and cleaned. After removal of the frame, the top of the catch basin shall be trimmed to provide a suitable foundation for the new material. Frames and grates shall then be reinstalled according to the requirements of Subsection 503-3.01.

Where reconstruction of a catch basin requires partial removal of concrete, sufficient concrete shall be removed to permit new reinforcing steel to be spliced to existing reinforcing steel in accordance with the requirements of Subsection 605-3.02. Existing reinforcing incorporated into the new work shall be thoroughly cleaned of all adhering material before being embedded in new concrete. New concrete shall be placed according to the requirements of Section 601.

503-3.03 Frame and Grate:

Where an existing and grate for a catch basin is unfit for further use, a new frame and grate shall be furnished and installed as specified under Subsection 503-3.01.

Where existing frame and grate is suitable for reuse and is lost or damaged by the contractor's operations to the extent that it is unacceptable for reuse, it shall be replaced at no additional cost to the Department.

503-4 Method of Measurement:

Catch basins will be measured as a unit for each catch basin, including frame and grate; for each catch basin reconstructed; or for each frame and grate furnished.

503-5 Basis of Payment:

The accepted quantities of catch basins, of reconstruct catch basins, and of frame and grate for catch basin, measured as provided above, will be paid for at the contract unit price

each, complete in place, including aprons, temporary construction drains, excavation and backfill.

The removal of unsuitable material below the required depth and the furnishing and placing of material in the voids thus created will be paid for in accordance with the provisions of Subsection 104.02.

SECTION 504 STANDPIPES:

504-1 Description:

The work under this section shall consist of furnishing all materials and constructing standpipes for irrigation or drainage pipes, including excavation, backfill, covers and gates, at the locations designated on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

504-2 Materials:

504-2.01 Concrete:

Concrete shall be Class B Portland cement concrete conforming to the requirements of Section 1006.

504-2.02 Concrete Pipe:

Concrete pipe materials shall conform to the requirements of Section 1010.

504-2.03 Mortar:

Mortar for pipe joints shall conform to the requirements of Subsection 503-2.03.

504-2.04 Metal Covers:

Materials furnished for structural steel plate and bars in steel plate covers shall conform to the requirements of Section 1004 for structural carbon steel.

504-2.05 Metal Gates:

Materials furnished for metal gates shall conform to the requirements specified on the plans or in the Special Provisions.

504-3 Construction Requirements:

For a standpipe using reinforced concrete pipe, the pipe shall be placed so that the bell or grooved end is uppermost to receive the cover. All connections to new or existing pipes will be considered as being a part of the standpipe. Mortar joints shall be made in accordance with the details shown on the plans and shall be watertight.

Concrete standpipes shall be constructed in accordance with the requirements of Section 601.

Excavation and backfill shall be in accordance with the requirements of Subsection 203-5.

504-4 Method of Measurement:

Standpipes, of the types specified on the project plans, will be measured as a unit for each type constructed.

504-5 Basis of Payment:

The accepted quantities of standpipes, measured as provided above, will be paid for at the contract unit price each, complete in place, including excavation and backfill.

The removal of unsuitable material below the required depth and the furnishing and placing of material in the voids thus created will be paid for in accordance with the provisions of Subsection 104.02.

SECTION 505 MANHOLES:

505-1 Description:

The work under this section shall consist of furnishing all materials and constructing complete manholes including frames and covers; furnishing and installing manhole frames and covers; or removing and resetting existing manhole frames and covers at the locations designated on the project plans and in accordance with the details shown on the plans and the requirements of these specifications.

505-2 Materials:

505-2.01 Concrete:

Materials furnished for Portland cement concrete shall conform to the requirements of Section 1006 for Class B concrete, except precast manholes. Precast manholes shall conform to the requirements of AASHTO M 199 except that the compressive strength of each unit will be determined and accepted in accordance with Subsection 1006-7.

505-2.02 Reinforcing Steel:

Materials furnished for reinforcing steel shall conform to the requirements of Section 1003.

505-2.03 Brick:

Brick shall conform to the requirements of AASHTO M 91.

505-2.04 Mortar:

Mortar shall conform to the requirements of Subsection 503-2.03.

505-2.05 Frames and Covers:

Frames and covers shall conform to the requirements of Subsection 1004-6 for drainage structure castings. The bearing face of the frame shall be machined so that the cover will lie flat in any position in the ring and have a uniform bearing throughout its entire circumference. Before leaving the foundry, the frames and covers shall be thoroughly cleaned.

505-3 Construction Requirements:

505-3.01 Manhole:

The excavation for the manhole shall be in accordance with the requirements of Subsection 203-5.

All connections for lateral pipes will be considered a part of the manhole. The invert channel may be lined with split pipe.

Manhole side-walls shall be constructed of cast-in-place or precast concrete, or brick, as shown on the project plans. The base of all manholes shall be cast-in-place concrete.

A list of approved precast units will be found in the Special Provisions.

Cast-in-place concrete shall be placed in accordance with the requirements of Section 601.

Bricks for side-walls shall be wetted before being used and shall be laid in full mortar beds. Mortar that has been mixed for more than one hour shall not be used. Re-tempering of mortar will not be permitted.

Proper equipment shall be provided for lowering the precast sections to position. The tongue end of the section shall be placed in contact with the base structure unless otherwise directed. Not more than two holes shall be cast or drilled in the shell of each section for the purpose of handling and placing. If such holes are provided, they shall be filled and finished with mortar after placing. Any precast section damaged during handling or placing shall be repaired or replaced at the option of the Engineer and at no additional cost to the Department.

Joints for precast concrete manhole sections shall be made with Portland cement mortar, rubber gaskets, mastic joint fillers or by a combination of these types, or other approved type. The completed mortar joint shall be formed with a bead on the outside and finished smooth on the inside of the sections and suitably cured. The rubber ring gaskets shall be installed so as to form a flexible watertight seal. The mastic joint filler shall conform to the requirements of AASHTO M 198 and shall be applied in accordance with the manufacturers recommendations so as to form a watertight seal.

Where frames and covers for new manholes are to be set in new bituminous mix or asphaltic concrete surfaces, they shall not be set until the roadway has been surfaced. Where a bituminous seal coat or asphaltic concrete finishing course is to be placed on the new surfacing, the frames and covers shall be set after the surface course has been completed and prior to the placement of the seal coat or the finishing course.

Steel plates of a size approved by the Engineer shall be placed over the manhole prior to surfacing operations. After surfacing operations are completed, the steel plates shall be removed and the frames and covers set in concrete at the proper elevation so that the cover will be flush with the adjacent finished surface. Care shall be taken that the base and surfacing materials are not disturbed beyond the edges of the plate. Concrete and reinforcing steel shall be placed around the frame as detailed on the plans. The concrete shall be protected during the curing period.

Upon completion each manhole shall be thoroughly cleaned and kept clean until final acceptance of the work.

The contractor shall observe all the ordinances of the city or town in which the work is located. Streets shall be kept open for passage of traffic and protection for the public shall be provided when the manhole excavation is exposed and dangerous. The manhole construction work shall be completely and adequately covered when no work is being done. Every precaution shall be taken to prevent water pumped from manholes from flooding streets, alleys, sidewalks and private property.

505-3.02 Frame and Cover for Manhole:

Where an existing frame and cover for a manhole is unfit for further use, a new frame and cover shall be furnished and installed as specified under Subsection 505-3.01. Where necessary, existing side-walls shall be adjusted to the required grade by removing portions of, or adding to, the existing walls. Such adjustments shall conform to the details of the existing manhole unless otherwise detailed on the project plans.

505-3.03 Reset Manhole Frame and Cover:

Existing frames and covers to be reset shall be carefully removed and reset to the required grade in accordance with the requirements of Subsection 505-3.02; however, at the contractor's option and with approval of the Engineer, adjustable extension rings of the type which do not require the removal of the existing frame may be used. The extension device shall provide positive locking action with the existing frame and shall permit adjustment in height to conform to the new finish pavement surface. The material for the extension device shall be compatible with the existing frame and conform to the requirements of Section 1004.

Manhole frames and covers to be reset which are lost or damaged by the contractor's operations shall be replaced at no additional cost to the Department.

505-4 Method of Measurement:

Manholes will be measured as a unit for each manhole, including frame and cover; for each frame and cover; or for each existing frame and cover removed and reset.

505-5 Basis of Payment:

The accepted quantities of manholes, frame and cover for manhole, and reset manhole frame and cover, measured as provided above, will be paid for at the contract unit price each, complete in place, including excavation and backfill.

The removal of unsuitable material below the required depth and the furnishing and placing of material in the voids thus created will be paid for in accordance with the provisions of Subsection 109.04.

SECTION 506 UNDERDRAINS:

506-1 Description:

The work under this Section shall consist of furnishing all labor, equipment, and materials to construct an underdrain system in accordance with the details shown on the project plans and as directed by the Engineer.

When more than one type of pipe is allowed to be installed at underdrain installations, the underdrain will be designated as alternative pipe underdrain on the plans and in the bidding schedule. The type of pipe to be installed shall be selected by the contractor from the allowable types of pipe shown on the plans.

506-2 Materials:

506-2.01 Pipe Materials:

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted for all pipe materials.

(A) Perforated Clay Pipe:

Perforated clay pipe shall conform to the requirements for extra-strength perforated clay pipe as specified in AASHTO M 65, except that plain end pipe complying in all other respects with the stated AASHTO M 65 specification may be used.

Design modifications to the bell socket end of the pipe which will facilitate positioning of the perforations or placement of the pipe may be made, provided that such modifications are approved by the Engineer prior to use. Pipe so modified shall conform to all performance requirements and tests specified in AASHTO M 65.

If plain end pipe is used, couplers which are capable of holding the pipe in alignment shall be used to join the pipe.

(B) Perforated Steel Pipe:

Perforated steel pipe and coupling bands shall conform to the requirements of AASHTO M 36 and M 218, with the following modifications: The pipe shall conform to any one of the full-circle types specified in AASHTO M 36, and perforations in the pipe shall be either drilled or punched. The perforations shall be located either in the inside crests or in the flat tangent portion of all corrugations, but not in both locations in a given length of pipe.

(C) Perforated Aluminum Pipe:

Aluminum underdrain pipe and fittings shall conform to the requirements of AASHTO M 196 with the following modifications: The pipe shall conform to Type III pipe according to AASHTO M 196. Perforations in the pipe shall be either drilled or punched. The minimum thickness of sheet shall be 0.06 inches.

(D) Perforated Plastic Pipe:

Perforated plastic pipe shall be either smooth-wall polyvinyl chloride plastic pipe, corrugated polyvinyl chloride plastic pipe with a smooth interior surface, or corrugated polyethylene plastic tubing.

Smooth-wall polyvinyl chloride plastic pipe shall conform to the requirements of AASHTO M 278.

Corrugated polyvinyl chloride plastic pipe with a smooth interior surface shall conform to the material and structural requirements of AASHTO M 278. The pipe shall have perforations located in the bottom half of the pipe and the perforations shall consist of slots meeting the size and opening area requirements listed in AASHTO M 252. The inside diameter and diameter tolerances shall conform to the requirements of either AASHTO M 252 or M 278.

Corrugated polyethylene plastic tubing shall conform to the requirements of AASHTO M 252 or M 294.

Polyvinyl chloride pipe shall be connected with belled ends, or with sleeve-type or stop-type couplings conforming to the requirements of AASHTO M 278. Polyethylene tubing shall be connected with snap-on, screw-on, or wrap-around fittings and couplings conforming to the requirements of AASHTO M 252 or M 294. Solvent cementing of joints will not be required.

506-2.02 Underdrain Outlets and Risers:

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted for all underdrain outlet and riser materials.

Underdrain outlets and underdrain terminal risers, vertical risers, and 45-degree risers, consisting of covers, pipes, band couplers, pipe elbows, tees and wyes shall be furnished and installed in accordance with the details shown on the plans and as specified in these specifications.

Underdrain outlets and risers shall be fabricated of the same material as the underdrain pipe or of corrugated metal pipe. Except for covers and coupling band fastening hardware, aluminum and steel shall not be mixed in any installation. Outlet and riser pipe and fittings shall not be perforated.

The welded metal cover for risers shall conform to the details shown on the plans. Welded steel covers shall be galvanized after fabrication, in accordance with the provision in Subsection 604-3.05, Galvanizing.

Welding shall be in accordance with the requirements in Subsection 604-3.06, Welding.

Covers shall be fitted and bolted into the riser pipe or elbow. The covers shall seat uniformly and shall not be subject to rocking.

506-2.03 Drain Aggregate:

The drain aggregate shall conform to the following gradation when tested in accordance with the requirements of Arizona Test Method 201.

Sieve Size	Percent Passing
1-1/2 inch	100
1 inch	95 - 100
1/2 inch	25 - 60
No. 4	0 - 10
No. 8	0 - 5
No. 10	0 - 2

For underdrains within the roadway prism, the percent of fractured coarse aggregate particles for material retained on the No. 4 sieve shall be at least 90 when tested in accordance with the requirements of Arizona Test Method 212, unless otherwise approved by the Engineer.

The combined bulk specific gravity range for the aggregate shall be 2.35 to 2.85.

The combined water absorption range for the aggregate shall be 0 to 2.5.

Resistance to abrasion for aggregate will be determined in accordance with the requirements of AASHTO T 96 and shall meet the following requirements:

Maximum loss of 9 percent at 100 revolutions.

Maximum loss of 40 percent at 500 revolutions.

506-2.04 Drainage Geotextile Fabric:

The drainage geotextile fabric shall be as specified in Subsection 1014-9.

506-3 Construction Requirements:

506-3.01 General:

The trench for the underdrain shall be excavated to the lines and grades shown on the project plans. The bottom of the trench shall be shaped in accordance with the details shown on the plans and prepared to provide full, firm and uniform support for the drainage geotextile fabric, aggregate, and perforated pipe.

506-3.02 Weather Limitations:

Drainage fabric placement and underdrain installation shall not be done when weather conditions, in the opinion of the Engineer, are not suitable to allow placement or installation.

Exposure of geotextiles to the elements between lay down and cover shall be a maximum of 14 days to minimize damage potential.

506-3.03 Fabric Placement:

Surfaces to receive drainage fabric, immediately prior to placing, shall be free of loose or extraneous material and sharp objects that may damage the fabric during installation. The fabric shall be aligned and placed in a wrinkle-free manner. Successive sheets or rolls of fabric shall be overlapped a minimum of 12 inches in the direction of water flow. The drain aggregate shall also be placed in the trench in the direction of water flow, if possible. Should the fabric be damaged during placing, the torn or punctured section shall be either completely replaced or shall be repaired by placing a piece of fabric that is large enough to cover the damaged area and to meet the overlap requirement. Damage to the fabric resulting from the contractor's vehicles, equipment or operations shall be replaced or repaired by the contractor at no additional cost to the Department.

506-3.04 Underdrain Construction Details:

Aggregate materials shall be placed with great care in a manner which does not damage the fabric. Pins or piles of aggregate can be used to hold the drainage fabric in place while aggregate is being placed. Aggregate materials shall be compacted in six-inch maximum lifts with a minimum of three passes of a vibratory plate type compactor.

Perforated pipes shall be laid with the perforations down.

Outlets, riser pipes, and associated fittings shall be constructed in accordance with the details shown on the plans and specifications and as directed by the Engineer.

The outlet for each underdrain shall be clean at the time of installation and shall be free of obstructions after installation. Pipes that are found to be plugged shall be replaced by the contractor, including replacement of aggregate materials, surfacing and backfill materials, at no additional cost to the Department.

After placing the drain aggregate, the geotextile drainage fabric shall be folded over the top of the drain aggregate to produce a minimum overlap of 12 inches for trenches greater than

12 inches wide. In trenches less than 12 inches in width, the overlap shall be equal to the width of the trench. The geotextile drainage fabric shall then be covered with the subsequent course.

506-4 Method of Measurement:

Underdrains will be measured by the linear foot along the centerline of the pipe. Measurement will be made end-to-end to the nearest foot along the actual length of pipe. The pay length shall not exceed the length staked or ordered by the Engineer.

Elbows, wyes, tees, risers, outlets, and other branches will be measured by the linear foot for the size and type of underdrain pipe they are connected to. Elbows, outlets and risers will be measured along centerline. Wyes, tees, and other branches will be measured along centerlines to the point of intersection.

The total linear feet measured of each type and size of underdrain pipe shall be the sum of the above measured quantities.

506-5 Basis of Payment:

The accepted quantities of each type and size of underdrain measured as provided above, will be paid for at the contract unit price per linear foot, complete in place. The contract price shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals involved in installing perforated pipe, drainage fabric, and aggregate material as specified in the plans and specifications, and as directed by the Engineer. The contract unit price shall also include connecting outlets to drainage facilities, welded metal covers, and any necessary excavation and backfill.

SECTION 507 EDGE DRAINS:

507-1 Description:

The work under this Section shall consist of furnishing all labor, equipment, and materials to construct an edge drain system in accordance with the details shown on the project plans and as directed by the Engineer. The edge drain system shall include installation of plastic pipe edge drains and edge drain outlets, vents, and cleanouts, and furnishing and placing permeable drain material, filter fabric and miscellaneous appurtenances as shown on the plans and as specified in these specifications and Special Provisions.

507-2 Materials:

507-2.01 Pipe Materials:

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted for all pipe material.

Pipe and pipe fittings for edge drains and edge drain outlets, vents, and cleanouts shall be of the size shown on the project plans.

Pipe installed in trenches to be backfilled with asphalt-treated permeable material shall be polyvinyl chloride (PVC) 90 °C electric plastic conduit, EPC-40 or EPC-80, conforming to the requirements of NEMA Specification TC-2.

All pipe for edge drains and edge drain outlets, vents, and cleanouts shall, at the contractor's option, conform to one of the following:

- (A) PVC 90 °C electric plastic conduit, EPC-40 or EPC-80, conforming to the requirements of NEMA Specification TC-2.
- (B) PVC plastic pipe, Schedule 40 or Schedule 80, conforming to the requirements of ASTM D 1785. The type, grade, and design stress designation of the pipe shall be either 1120, 1220, 2120, 2116, 2112, or 2110 as specified in ASTM D 1785.

Pipe shall be straight-end or bell-end. Bell and sockets shall conform to the requirements of ASTM D 2672 except for the marking.

In addition, pipe designated as slotted on the plans shall have three rows of slots in the pipe. The rows shall be in the longitudinal direction of the pipe and the slots shall be cut in the circumferential direction of the pipe. The three rows shall be spaced equally around the circumference of the pipe. Each row shall have $22 \pm$ one uniformly spaced slots per linear foot of pipe. The slots shall be 0.045 to 0.065 inches wide and of such length as to provide a minimum of 2.00 square inches of slot opening per linear of pipe. Other suitable configurations of slots which provide drainage equal to or better than the above slot requirements may be used if approved in writing by the Engineer.

Except as otherwise provided for wye fittings, fittings for PVC 90 °C electric plastic conduit shall conform to the requirements of NEMA Specification TC-3, and the fittings for PVC plastic pipe shall be socket-type fittings conforming to ASTM D 2467 for Schedule 80 pipe and ASTM D 2466 for Schedule 40 pipe. Wye fittings shall be shop fabricated from pipe conforming to the requirements for the type of edge drain pipe installed. The fitting shall provide an unobstructed passageway through both legs of the wye.

507-2.02 Treated Permeable Material:

Permeable material for edge drains shall be asphalt treated permeable material or cement treated permeable material. The type of treatment (asphalt or cement) for the permeable material shall be at the contractor's option.

Treated permeable material shall be stored, proportioned, and mixed in accordance with the requirements of these specifications.

(A) Asphalt Treated Permeable Material:

Aggregates shall be clean and free from decomposed materials, organic material, and other deleterious substances.

The gradation of the aggregate shall meet the following requirements when tested in accordance with Arizona Test Method 201:

Sieve Size	Percent Passing
1 inch	100
3/4 inch	90 - 100
1/2 inch	35 - 65
3/8 inch	20 - 45
No. 4	0 - 10
No. 8	0 - 5
No. 200	0 - 2.0

Aggregate shall conform to the following quality requirements prior to the addition of asphalt:

Tests	Test Method	Requirement
Fractured Coarse Aggregate Particles	Arizona Test Method 212	Min. 90%
Abrasion	AASHTO T 96	500 Rev., Max. 45%
Sand Equivalent	AASHTO T 176	Min. 55

The combined bulk specific gravity range for the aggregate shall be 2.35 to 2.85.

The combined water absorption range for the aggregate shall be zero to 2.5.

Asphalt to be mixed with the aggregate shall be PG 64_16 unless otherwise specified or approved by the Engineer.

Aggregates and asphalt for asphalt treated permeable material shall be stockpiled, proportioned and mixed in the same manner provided for in Subsection 406-10, except as follows:

The aggregate need not be separated into sizes. The temperature of the aggregate before adding the asphalt binder shall not be less than 275 degrees F nor more than 325 degrees F. Asphalt treated permeable material stored in excess of two hours shall not be used in the work. The aggregate shall be combined with 2.5 percent paving asphalt by weight of the dry aggregate. After testing samples of the contractor's proposed aggregate supply, the Engineer may order an increase or decrease in the target asphalt content. If such increase or decrease is ordered, and the increase or decrease shall be less than 0.5 percent by weight of the dry aggregate, no additional compensation for this increase or decrease of asphalt content will be payable to the contractor for the asphalt treated permeable material. Once the target asphalt content is determined, the asphalt cement content will be accepted in accordance with Subsection 406-9.03(B).

(B) Cement Treated Permeable Material:

Aggregates shall be clean and free from decomposed materials, organic material, and other deleterious substances. All natural aggregates shall be thoroughly and uniformly washed before use.

The gradation of the aggregate shall meet the following requirements when tested in accordance with Arizona Test Method 201:

Sieve Size	Percent Passing
1-1/2 inch	100
1 inch	88 - 100
3/4 inch	50 - 80
3/8 inch	15 - 40
No. 4	0 - 16
No. 8	0 - 6
No. 200	0 - 2.0

Aggregate shall conform to the following additional quality requirements prior to the addition of cement:

Tests	Test Method	Requirement
Fractured Coarse Aggregate Particles	Arizona Test Method 212	Min. 90%
Abrasion	AASHTO T 96	500 Rev., Max. 45%
Sand Equivalent	AASHTO T 176	Min. 55

The combined bulk specific gravity range for the aggregate shall be 2.35 to 2.85.

The combined water absorption range for the aggregate shall be zero to 2.5.

Aggregates and cement for cement treated permeable material shall be stockpiled, proportioned and mixed in the same manner provided for in Subsection 1006-4, except as follows:

Dividing of the aggregate into sizes will not be required. The Portland cement content of cement treated permeable material shall be no less than 282 pounds per cubic yard. The water:cement ratio (the ratio of the amount of water, exclusive only of that absorbed by the aggregate, to the amount of cement, by weight) shall be approximately 0.37:1. The exact water:cement ratio shall be as specified or approved by the Engineer.

(C) Drainage Geotextile Fabric:

The drainage geotextile fabric shall be as specified in Subsection 1014-9.

(D) Miscellaneous Materials:

Concrete for splash pads shall conform to the requirements of Class B concrete.

Mortar placed where edge drain outlets and vents connect to drainage pipes and existing drainage inlets shall be composed of Portland cement, fine aggregate, and water proportioned and mixed as specified herein.

The proportion of cement to fine aggregate, measured by volume, shall be one-to-two (1:2), unless otherwise specified.

All materials used in the mortar shall conform to the requirements listed in Subsection 1006-2.

The mortar shall contain only enough water to permit placing and packing.

Concrete areas in contact with the mortar shall be cleaned of all loose or foreign material that would in any way prevent bond between the mortar and the concrete surfaces and shall be flushed with water and allowed to dry to a surface dry condition immediately prior to placing the mortar.

The mortar shall completely fill and shall be tightly packed into recesses and holes, on surfaces, under structural members, and at other locations as specified. After placing, all surfaces of mortar shall be cured by the water method as provided for in Subsection 1006-6.01(B) for a period not less than three days.

All improperly cured or otherwise defective mortar shall be removed and replaced by the contractor at no additional cost to the Department.

Expansion type pressure plugs for cleanouts shall seat firmly against the lip of the pipe, and shall be an expandable plug manufactured from neoprene or commercial quality expandable duct plugs. The expandable plug shall consist of reinforced polypropylene rigid threaded plug with a commercial quality thermoplastic rubber sealing ring.

507-3 Construction Requirements:

507-3.01 General:

Edge drains, edge drain outlets, vents, cleanouts, treated permeable material, and filter fabric shall be installed in accordance with the details shown on the plans and as specified herein unless otherwise approved by the Engineer.

Prior to excavating trenches in existing paved areas, the outline of the paved areas to be removed shall be cut to a neat line to a minimum depth of two inches with a power-driven saw or a wheel type rock cutting excavator. Cuts along the joint between existing asphalt concrete and existing Portland cement concrete pavement will not be required.

507-3.02 Weather Limitations:

Drainage fabric placement and edge drain installation shall not be done when weather conditions, in the opinion of the Engineer, are not suitable to allow placement or installation.

Exposure of geotextiles to the elements between lay down and cover shall be a maximum of 14 days to minimize damage potential.

507-3.03 Fabric Placement:

Surfaces to receive drainage fabric shall, immediately prior to placing, be free of loose or extraneous material and sharp objects that may damage the fabric during installation. The fabric shall be aligned and placed in a wrinkle-free manner. Successive sheets or rolls of fabric shall be overlapped a minimum of 12 inches in the direction the material is being spread. Should the fabric be damaged during placing, the torn or punctured section shall be either completely replaced or shall be repaired by placing a piece of fabric that is large enough to cover the damaged area and to meet the overlap requirement. Damage to the fabric resulting from the contractor's vehicles, equipment or operations shall be replaced or repaired by the contractor at no additional cost to the Department.

507-3.04 Edge Drain Construction Details:

Pipe and fittings shall be joined by solvent cementing. The solvent cement and primer shall be of commercial quality specifically manufactured for use with rigid PVC plastic pipe and fittings. The solvent cement and primer used shall be made by the same manufacturer. The color of the primer shall contrast with the color of the pipe and fittings. The solvent cement and primer shall be used in accordance with the manufacturer's printed instructions.

Treated permeable material shall be spread only when the atmospheric temperature is above forty degrees F and in layers not to exceed eight inches.

When edge drains are to be installed adjacent to an asphalt treated permeable base, the treated permeable material may be spread with the treated permeable base, except for the lower six inches of asphalt treated permeable material, which shall be spread in a separate operation.

Asphalt treated permeable material shall be placed at a temperature of not less than 180 degrees F nor more than 230 degrees F. When asphalt treated permeable material is spread with asphalt treated permeable base, the placement shall conform to the temperature requirements for spreading asphalt treated permeable base.

Treated permeable material spread with adjacent treated permeable base shall be compacted in the same manner as specified for compacting the base. All other layers of treated permeable material shall be compacted with a vibrating shoe-type compactor connected to a spreading device. The vibrating shoe-type compactor shall be in operation only when the material is being spread in the trench.

Cement treated permeable material which is not covered with asphaltic concrete within 12 hours after compaction of the permeable material shall be cured by either sprinkling the material with a fine spray of water every four hours during daylight hours or covering the material with a white polyethylene sheet, not less than six mils thick. The above curing requirements shall begin at 7:00 a.m. on the morning following compaction of the cement treated permeable material and continue for the next 72 hours or until the material is

covered with asphaltic concrete, whichever is less. The cement treated permeable material shall not be sprayed with water during the first 12 hours after compacting, but shall be covered with the polyethylene sheet from the completion of the compaction to the beginning of the cure period.

Trenches in the existing embankment areas shall be backfilled with native material and compacted as directed by the Engineer.

Aggregate base for backfilling trenches in existing paved areas shall be Class 1, 2, or 3 aggregate base. Aggregate base backfill shall be spread and compacted by methods that will produce a uniform base, firmly compacted, and free from pockets of coarse or fine material.

Asphaltic concrete for backfilling trenches in existed paved areas shall be dense graded asphaltic concrete material as approved by the Engineer. Prior to placing the asphaltic concrete backfill, a tack coat of asphaltic emulsion shall be applied to the vertical edges of existing pavement at an approximate rate of 0.05 gallons per square yard. Asphaltic concrete backfill shall be spread and compacted in approximately two equal layers by methods that will produce an asphaltic concrete surfacing of uniform smoothness, texture and density. Each layer shall be compacted before the temperature of the mixture drops below 250 degrees F.

Surplus excavated materials shall become the property of the contractor and shall be disposed of in accordance with the specifications outside the right of way.

The locations of outlets, vents and cleanouts will be marked with soil anchored flexible delineator posts in accordance with the plans and as approved by the Engineer.

The edge drain outlet, vent, and cleanout pipes shall be clean at the time of installation and shall be free of obstructions after installation. The contractor shall use a high pressure, flexible hose with a nominal one-inch diameter nozzle containing flushing and propelling jets. The hose shall be inserted into each edge drain outlet, vent, and cleanout pipe and pushed through the pipe with a minimum 1,000 pounds per square inch water pressure so that the entire edge drain system will be penetrated by the flushing nozzle. Pipes that are found to be plugged shall be replaced by the contractor, including replacement of treated permeable material, surfacing and backfill materials, at no additional cost to the Department.

Outlet and vent covers consisting of commercial quality 1/2-inch mesh galvanized metal screens or grates with polyvinyl chloride slip joint nut fittings shall be installed at the end of each outlet pipe and vent pipe.

507-4 Method of Measurement:

The various sizes of edge drains, drain outlets, splash blocks, vents and cleanouts, as shown on the plans, will be measured by the linear foot along the centerline of the pipe and shall include the length of fittings. Tees, wyes and other branches will be measured as pipe along the central axis of the pipes to the point of intersection. Measurement will be made

end to end to the nearest foot along the actual length of pipe. The pay length shall not exceed the length staked or ordered by the Engineer.

The total linear feet measured of each type and size of underdrain pipe shall be the sum of the above measured quantities.

507-5 Basis of Payment:

The accepted quantities of each type and size of edge drain measured as provided above, will be paid for at the contract unit price per linear foot, complete in place. The contract price shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals involved in installing perforated pipe, drainage fabric, and treated permeable material as specified in the plans and specifications, and as directed by the Engineer.

This contract unit price shall also include outlet and vent covers, expansion plugs, flexible markers for future location, concrete splash pads, connecting outlets and vents to drainage facilities, and any necessary excavation and backfill of aggregate base, asphaltic concrete, asphalt emulsion tack coat, and native materials.

No deduction in the length of plastic pipe will be made for gaps in edge drain pipe at locations of dual outlet, dual vent, or dual outlet and vent connections to the edge drain.